NON-PUBLIC?: N
ACCESSION #: 9109190263
LICENSEE EVENT REPORT (LER)

FACILITY NAME: Dresden Nuclear Power Station, Unit 3 PAGE: 1 OF 09

DOCKET NUMBER: 05000249

TITLE: Reactor Scram Due to Degraded Main Stop Valve Fast Acting
Solenoid Valve Fast Acting Solenoid Valve
EVENT DATE: 08/17/91 LER #: 91-006-00 REPORT DATE: 09/16/91

OTHER FACILITIES INVOLVED: N/A DOCKET NO: 05000

OPERATING MODE: N POWER LEVEL: 056

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR
SECTION:
50.73(a)92)(iv)

LICENSEE CONTACT FOR THIS LER:
NAME: John O'Neill, Technical Staff Group TELEPHONE: (815) 942-2920
Leader Ext. 2783

COMPONENT FAILURE DESCRIPTION:
CAUSE: X SYSTEM: TA COMPONENT: PSV MANUFACTURER: P070
REPORTABLE NPRDS: Y

SUPPLEMENTAL REPORT EXPECTED: No

ABSTRACT:

On August 17, 1991, at 0116 hours, with Unit 3 operating at 56% rated core thermal power, a reactor scram occurred during surveillance testing of the Main Turbine Stop Valves (MSVs). While testing the #2 MSV, the Fast Acting Solenoid Valve (FASV) was not positioning properly, thus allowing a drop in the Emergency Trip System (ETS) oil pressure. This allowed the Combined Intermediate Valve Stop Valve (CIV SV) disk dump valves to actuate, resulting in the subsequent fast closure of the CIV SVs. Generator load dropped from 394 MWe to 25 MWe. As Reactor Recirculation flow was reduced, the Generator electrical output dropped to -1.5 MWe. This caused the generator to trip on reverse power. The generator trip caused a subsequent turbine trip, which resulted in an automatic reactor scram when the turbine MSVs closed. Subsequent testing of the MSVs, following the event, could duplicate closure of only one of the CIV SV's.

Following the reactor scram, voltage on Bus 33-1 dropped below 4000 volts (normal is 4160 volts). The voltage drop was addressed and compensatory actions were taken per Operating Order #20-91, Compensatory Actions Associated with Degraded Voltage. As corrective actions for this event, the #1 and #2 MSV FASVs were replaced. Periodic replacement of the FASVs will be made a preventative maintenance item. Also, orifice plugs will be installed at the ETS inlet to FASVs to prevent temporary loss of ETS pressure. These plugs will be installed during the current Unit 3 Refuel Outage. The safety significance of this event was considered to be minimal since all reactor scram functions operated properly and the reverse power relay functioned to prevent damage to the main generator. MSV FASV failures of this type have not been a previous adverse trend.

END OF ABSTRACT

PLANT AND SYSTEM IDENTIFICATION:

General Electric - Boiling Water Reactor - 2527 MWt rated core thermal power

Nuclear Tracking System (NTS) tracking code numbers are identified in the text as (XXX-XXX-XX-XXXXX)

EVENT IDENTIFICATION:

Reactor Scram Due To Degraded Main Stop Valve TA! Fast Acting Solenoid Valve

A. CONDITIONS PRIOR TO EVENT:

Unit: 3 Event Date: 8-17-91 Event Time: 0116 Hours

Reactor Mode: N Mode Name: Run Power Level: 56%

Reactor Coolant System (RCS) Pressure: 1002 psig

B. DESCRIPTION OF EVENT:

On August 17, 1991, at 0116 hours with Unit 3 at 56% Rated Core Thermal Power, Dresden Operating Surveillance (DOS) 5600-2, Monthly and Weekly Turbine Checks, was being performed. Step 2 of DOS 5600-2 tests the exercising and closure of the Main Turbine TA! Stop Valves (MSVs). Normally, the MSV will slow close to about 10%

open, then fast close the final 10%. The first Stop Valve to be tested was the Number 1 Stop Valve. When the Reactor Operator (RO) depressed the test button the Stop Valve smoothly closed to approximately 50% open and then hovered. The RO immediately released the test button, and t
e Stop Valve returned to its full
open position. After consulting with another RO and a Station Control Room Engineer (SCRE) it was decided to retest the #1 MSV. The test button was pressed again and this time the Number 1 Stop Valve slow closed to 10% open and then fast closed the rest of the way as expected. The test button was released and the the Stop Valve returned to its normal full open position.

The #2 MSV was the next valve to be tested. The RO pressed the test button and the Stop Valve closed normally. Upon the release of the test button, the Number 2 Stop Valve began to reopen; concurrently the six Combined Intermediate Valves (CIV) all ramped fast closed. The turbine crossover piping relief valves actuated, relieving steam to the main condenser. The main generator TB! electric output dropped from approximately 394 MWe to approximately 25 MWe. All reactor parameters (water level, neutron flux, pressure, power) were monitored and observed to be stable. The Main Turbine Control Valves were about 25% open, the Turbine Bypass Valves JI! were closed and the alarms which were received indicated the trip of the feedwater heaters.

Control Room personnel prepared for a manual scram by raising water level, transferring electric loads to the reserve auxiliary transformer EA!, and lowering reactor power by reducing Reactor Recirculation system AD! flow. As Recirculation flow and reactor power were lowered, generator output was reduced to approximately +2 to -1.5 MWe. At 0116 hours the main generator tripped on reverse power which in turn generated a main turbine trip. The main turbine trip with the reactor still above 45% reactor power caused the automatic reactor scram when the main turbine stop valves closed.

After the scram, the turbine bypass valves controlled reactor pressure. Reactor level decreased to approximately 1 inch, initiating the Group II and Group III Primary Containment Isolations (PCI) JM!. The B Standby Gas Treatment BH! (SBGT) train was in operation in the START mode, in anticipation of Unit 3 High Pressure Coolant Injection BJ! (HPCI) testing, and the A SBGT train properly started; however, the heater did not turn on. Subsequent review revealed that the system operated properly and the A heater should not have come on under the flow and initiation condition is experienced.

During the recent Dresden Station Electrical Distribution System Functional Inspection (EDSFI), the NRC performed a review of a preliminary Electrical Load Management System (ELMS) calculation of the auxiliary power system. This preliminary calculation showed that several 480 V-ac Motor Control Centers (MCC) could exhibit low voltage under degraded grid conditions. Based on these results, the NRC requested Commonwealth Edison Company (CECo) to verify that the existing degraded voltage relay setpoint (3708 volts on the 4 kV safety bus) was sufficient to start and operate all Class 1E equipment.

CECo performed a preliminary calculation of auxiliary power system voltages for Dresden Unit 2 Division II utilizing the Unit 2 Emergency Diesel Generator EK! Cooling Water Pump (DGCWP) as the most limiting Class 1E load. This load path was selected to support the review activities of the EDSFI inspection team. The DGCWP was selected since it was the largest electrical load on the lowest voltage MCC. The preliminary calculations determined that the minimum 4 kV-ac safety bus voltage to assure starting the DGCWP is approximately 3960 volts. Based on these results, compensatory measures were developed to ensure the availability of the DGCWP. These compensatory measures were discussed with NRR and Region III personnel on August 1, 1991, and incorporated into Dresden Operating Order 20-91.

During the scram event, the initial Low voltage alarm (at 4000 volts) for 4 kV safety bus 33-1 EB! came in at 01:16:39 (3 seconds after the scram) and was not immediately recognized by the Operators who were busy working to stabilize the Unit. At 01:43:14 the Low voltage alarm cleared and came back up at 01:43:20. The Unit RO and Shift Engineer discussed the Operating Order, and the Center Desk RO was instructed to talk to the Load Dispatcher about raising voltage (in accordance with the first step in the Operating Order). The Center Desk RO, the High Voltage Operator (HVO), and the Load Dispatcher were busy attempting to restore the 345 kV Switchyard EL! configuration following the Unit 3 Scram, consequently the HVO (who would normally start the DGCWP) was in the Switchyard. Therefore, due to the prioritization of duties following the scram, the WO was not immediately assigned to start the DGCWP (the second step of the Operating Order).

Approximately ten minutes later (at 01:53), the 345 kV bustie breaker OCB 4-8 was closed and voltage immediately improved but bus

33-1 voltage still remained slightly below 4000 volts until 02:42:36. The Unit RO continued to monitor bus voltage during the time while the Center Desk RO again pursued increased system voltage with the Load Dispatcher.

At 02:42:36 the Unit RO notified the Shift Engineer that the bus 33-1 Low voltage alarm was clearing and annunciating. The Unit RO logged the action that was being taken and the Shift Engineer called the Load Dispatcher about raising voltage. The HVO was dispatched to start the Unit 3 and 2/3 DGCWP's. At 03:03:06 VARS were raised on Unit 2 Main Generator and voltage subsequently increased in the 345 kV Switchyard. As a result, bus 33-1 voltage increased above 4000 volts. The Unit 3 and 2/3 DGCWP's were started at 03:08:12 and 03:11:02.

C. APPARENT CAUSE OF EVENT:

This report is submitted in accordance with Title 10 of the Code of Federal Regulations Part 50 Section 73 (a) (2) (iv), which states that any event that results in unplanned manual or automatic actuation of any Engineered Safety Feature, including the Reactor Protection System (RPS) must be reported.

During normal operation, the Emergency Trip System (ETS) is pressurized from the high pressure hydraulic fluid supply. The ETS supplies high pressure fluid to the disk dump valves. The purpose of the disk dump device is to fast close the steam valves by providing a suitable flow path to rapidly drain the Electro Hydraulic Control (EHC) fluid from the hydraulic cylinders following the appropriate trip signal. With ETS pressure applied below the disk, it will be firmly seated as the hydraulic pressure below the disc acts on a larger surface area than the pressure above the disk. Discharging the ETS pressure by actuating either the fast acting solenoid or one of the front standard trip valves will reverse the net forces and the cylinder pressure will force open the disk dump valve.

It is believed that, while testing the #2 MSV, the fast acting solenoid valve was not positioning properly, thus allowing a drop in ETS oil pressure. This pressure drop allowed the CIV SV disk dump valve to actuate, resulting in the subsequent fast closure of the CIV Stop Valves. Testing of the #2 MSV, while monitoring ETS oil pressure verified that the ETS pressure dropped significantly. The #1 CIV SV closure was duplicated numerous times by actuating the #2

MSV. The fast acting solenoid valves for the #1 and #2 MSVs were replaced. Thereafter, the CIV SV closure could not be duplicated and the ETS pressure drop was minimal. Therefore, the root cause is believed to be component failure due to degradation of the #1 and #2 MSV FASVs.

Figure 1 presents a simplified single line diagram of the AC power distribution system for Dresden Station. Prior to the scram, 4 kV safety bus 33-1 was fed from the unit auxiliary transformer (UAT) through bus 33, and 4kV safety bus 34-1 was fed from the reserve auxiliary transformer (RAT) through bus 34 (see Figure 1). In preparation for the manual scram, bus 33 was manually transferred to the RAT.

The voltage response of the 345 kv switchyard EL! and 4 kv safety busses (33-1 and 34-1) are presented in the following table. Figure 2 presents the voltage response for safety bus 33-1 during the event.

	345 kV Switchyard	4 kV Safety Bus 33-1	4 kV Safety Bus 34-1*
Before scram	355 kV	4240V	4370V (4160V)
Following scram	352 kV	3940V	4160V (3950V)

* Voltage in parentheses is a corrected value following calibration of bus voltage computer point.

Actions were performed to investigate the indicated bus voltage difference between safety buses 33-1 and 34-1. A review of the loading on each bus was performed, and it was determined that loads were essentially balanced. Additionally, a calibration of the control room meters and computer points associated with bus voltage for busses 33-1 and 34-1 was performed. As a result of this calibration, it was determined that the computer point for bus 34-1 voltage was out of tolerance and indicating approximately 210 volts higher than actual.

As shown in the table above, the voltage in the 345 kV switchyard decreased by approximately 1% following the scram. This decrease is expected since the Unit 3 output is provided to the 345 kV switchyard. Voltage on 4 kV safety bus 34-1, which was fed from normal off-site power throughout the event, decreased by approximately 210 volts (approximately 5%). Voltage on bus 33-1, which was transferred from the UAT to the RAT, decreased approximately 300 volts (approximately 7%) and indicated below 4000 volts. The majority of the voltage decrease on the safety buses has been attributed to the increased load on the RAT due to bus 33-1 load transfer to the RAT. A historical review of the most recent previous scram (from power) for each unit revealed that safety bus voltage had not decreased below 4000 volts. It is difficult, however, to predict the exact voltage drop associated with a scram due to variable operational factors such as: system load, switchyard voltage, UAT and RAT loading, and generator output (MWe and MVARs).

As indicated previously, the 345 kV switchyard voltages decreased from 355 kV to 352 kV (approximately 1%) as a result of this event. Grid voltage after the scram event was restored to approximately 354 kV primarily by the manual closing of the cross-tie breaker in the 345 kV switchyard. The grid voltage responded as expected with minimal disturbance.

A maintenance history review indicates that the FASV on the #2 MSV was last replaced on July 17, 1987 under work request (WR) 66917. The solenoid valve was replaced because the MSV would not fast close properly.

D. SAFETY ANALYSIS OF EVENT:

The initiating condition for this scram was the closure of all four turbine stop valves. Any combination of three or more MSVs each closed 10% or greater during normal power operation at greater than 45% will result in a reactor scram. The reactor scram occurs in anticipation of the pressure, neutron flux, and fuel cladding surface heat flux increase caused by the rapid closure of the MSVs and a postulated failure of the turbine bypass valves to open. An automatic reactor scram was the expected response to the MSV closures involved in this event. Additionally, the turbine bypass valves responded properly to the MSV closures. It should also be noted that the turbine crossover piping relief valves properly actuated to control pressure prior to the MSVs closing.

The main generator protective relaying is designed such that two circuits will independently trip the generator on reverse power. The first trip circuit, associated with a primary reverse power relay, is initiated following a turbine trip signal. This circuit is designed to trip the generator at -1.3 MWe after a 5 second time delay. The second trip circuit is associated with a secondary reverse power relay and is designed to trip the main generator at -1.3 MWe with a 15 second time delay in the absence of a turbine trip signal. Thus, the secondary reverse power relay will initiate a generator trip if no turbine trip signals are present. Also, the capability of tripping the turbine via Control Room Operator action (which trips the generator) exists in the event the first two lines of defense should fail.

In order to address potential degraded voltage issues on Unit 2 Operating Order #20-91 had been previously established. Conservatively, this was also applied to Unit 3, because of the similarity of the units and to provide for Operator consistency, until calculations could be performed for Unit 3. These issues were addressed as a result of an Electrical Distribution System Functional Inspection (EDSFI) performed by the NRC in July and August of 1991 and can also be referenced in Licensee Event Report (LER) 91-021/050237. The Operating Order addresses 4 kV system voltages and provides direction to the Operators to start Class IE equipment prior to reaching voltage levels where equipment starting is not guaranteed. When the Operators became aware of the need to begin implementing Operating Order #20-91, voltage on bus 33-1 had increased to 3990 volts, thereby assuring the starting of the DGCWP. Also, the DGCWP was not required to operate during this event.

Therefore, the safety significance of this event was considered to be minimal.

E. CORRECTIVE ACTIONS:

Corrective actions for this event involved an extensive testing to determine a root cause. The turbine manufacturer (General Electric) was involved in the evaluation of this event through the participation of their onsite representative and phone contacts with their district headquarters. The FASVs for the #1 and #2 MSVs were replaced and functionally tested satisfactorily. The FASVs which were removed have been turned over to General Electric for further testing. Further turbine valve testing will be performed during the current Unit 3 refueling outage (D3R12) in the Fall of 1991 (249-200-91-05001).

Walkdowns of steam piping and supports were performed to verify no damage had occurred from the event. The exterior of the main condenser was also inspected. A training package covering the scram, subsequent actions and problems, and plans for startup was prepared and presented to the Operations shift personnel prior to commencing the Unit 3 startup.

To prevent momentary ETS pressure drops when turbine stop valves are cycled some other stations have installed an orifice at the ETS inlet to the FASV. GE has recommended installation of orifice plugs in the "P" port of all steam admission valves. These orifices will be installed on the Unit 3 turbine valves during D3R12 (249-200-91-05002), and on Unit 2 during its next refueling outage (249-200-91-05003).

Electrical Maintenance will replace the FASVs every fourth refuel outage as a preventative maintenance measure (249-200-91-05004).

Dresden Station's evaluation of this event determined that during a scram recovery period (a period of high Operator activity) dependency on the low bus voltage computer alarm for prompt initiation of the compensatory measures associated with Operating Order 20-91 was not sufficient. Therefore, a temporary procedure change was initiated (on August 17, 1991) for Dresden General Procedure (DGP) 2-3, Unit 2(3) Reactor Scram, which directs the operator to check the 4 kV safety buses for a low voltage condition. If a low voltage condition exists, the procedure references Operating Order 20-91 for guidance. Additionally, the training package previously mentioned addressed the degraded voltage condition which occurred and the temporary procedure change to DGP 2-3.

Further review of the event determined that additional instructions were necessary to ensure prompt action is taken in accordance with the Operating Order. Operating Order 20-91 has been revised to emphasize the urgency of the actions in the Operating Order. The revision instructs the Operating Staff to immediately (as a first step) dispatch a qualified individual to start the DGCWP. Additionally, the Operating Order provides additional guidance on actions which would increase bus voltage, actions to be taken if the unit is on or off line, and immediate trending of bus voltage with the process computer. The Operating Order has been incorporated into a Dresden Abnormal Operating Procedure.

Commonwealth Edison is currently reviewing what further actions can be taken to better maintain switchyard and in-plant voltages to minimize occurrences of degraded voltages. Furthermore, Nuclear Engineering Department is reviewing other actions which can be taken to help minimize degraded voltages such as transformer tap setting changes and equipment changes. These actions will be further discussed with the NRC in CECo's response to the Dresden EDSFI Inspection Report.

F. PREVIOUS OCCURRENCES:

LER/Docket Numbers Title

89-006/050249 Reactor Scram Caused By Turbine Stop Valve Closure Due To Control Relay Failure

While performing Dresden Operating Surveillance 5600-2, Monthly, Weekly, and Daily Turbine Checks, a reactor scram occurred during testing of the #2 turbine main stop valve. A component failure resulted in the closure of all the stop valves. The initiating scram signal was the turbine stop valve closure. The corrective actions included replacement of the relays which function to prevent closure of the turbine stop valves when testing the #2 stop valve.

LER/Docket Numbers Title

86-025/050249 Unit 3 Turbine Stop valve 10% Closure Scram Due to Limit Switch Contact Failure.

This report documented a reactor scram due to component failure. Investigation of this event determined that limit switch SVOS-2 had momentarily opened and then reclosed as a result of the contacts being carbonized. This resulted in the closure of the Turbine Stop Valves. The corrective actions for this event involved replacement of limit switch SVOS-2.

G. COMPONENT FAILURE DATA:

Manufacturer Nomenclature Model Number Mfg. Part Number

Parker Hannifin Solenoid Valve N/A D3W4BVY14

An industry wide Nuclear Plant Reliability Data System (NPRDS) data base search revealed no reported previous failures of this type of fast acting solenoid valve.

Figure 1 omitted.

Figure 2 omitted.

ATTACHMENT 1 TO 9109190263 PAGE 1 OF 1

Commonwealth Edison
Dresden Nuclear Power Station
R.R. #1
Morris, Illinois 60450
Telephone 815/942-2920

September 16, 1991

EDE LTR #91-559

U.S. Nuclear Regulatory Commission
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Licensee Event Report #91-006-0, Docket #050249 is being submitted as required by Technical Specification 6.6, NUREG 1022 and 10 CFR 50.73(a)(2)(iv).

E. D. Eenigenburg
Station Manager
Dresden Nuclear Power Station

EDE/ade

Enclosure

cc: A. Bert Davis, Regional Administrator, Region III
File/NRC
File/Numerical
NRC Resident Inspector's Office

(ZDVR/306)

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